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EDITORIAL NOTES.

LIME FRUIT PRODUCTS.

Attention is drawn to the fact that a Fruit Growing Syndicate in the Lower Perak District, on whose estate the cultivation of limes has been taken up on a commercial scale, has recently despatched trade samples of its products to London for sale.

The following products were included in the shipment :—

Concentrated Lime Juice.

Hand-pressed oil of Limes.

Distilled oil of Limes.

There is every reason to expect that these trade samples will command a good price on the London market, though whether this country will be able to compete in the European market with Italy and the West Indies is still a matter for conjecture.

At present, consequent upon the depreciation of the lire, even the West Indies are finding it difficult to compete with Italy and it is understood that suggestions have been made for a preferential tariff in favour of West Indian Products landed in England.

5th March 1923.

FRUIT GROWING IN MALAYA.

Fruit Orchards in Malaya at present are few and far between yet small holders by taking up the matter seriously could obtain substantial profits by planting fruit trees and supplying the local market with fruits such as oranges, chikus, limes, etc.

These fruits will grow and market well in this country as has been proved by several men who are making good profits from small orchards.

A small holder in the Lower Perak District has a flourishing little Chiku and Orange orchard of ¼ acre extent. Propagation is carried on by marcottage—a process which all Malays know. Trees planted in this manner bear fruit in 16—18 months. The local market absorbs all the crops and a good business is done by selling marcotted plants at $1.10 per plant. So successful has the owner been that he is opening up new land to extend his fruit cultivation. Inquirers who are interested can obtain the name of the owner by applying to the Secretary for Agriculture and quoting the No. C.A.I. 297/22.

An enterprising Estate Manager near Batu Gajah has planted up a 20 acre orchard of fruit trees imported from Australia. The land is openly situated on gently undulating slopes facing West, North and East, and is contour-terraced to prevent wash. The soil in a fine loam containing laterite. The varieties planted are:—Washington Naval Oranges, Geneo Lemons, Villa Franca, Tahite Limes, Seedless' Pomelos, Scarlet Mandarin, Cunquat, Mandarins 4 varieties (Emperor, Beauty of Glen, Tangarine, Retreat) Bengal Citron, Early Sillitta Oranges ; they are all growing well and are aged from one to three years.

23rd April 1923.

THE CULTIVATION OF ORANGES (CITRUS AURANTIUM) IN THE MALAY PENINSULA.

By F. G. Spring.

IT is generally considered that the Malay Peninsula is not suitable for the growing of oranges. The orange is frequently cultivated particularly by Chinese, but the varieties are not of good quality ; they are of the green type which do not turn yellow and are, as a rule, too acid for dessert purposes being more suitable for the making of cooling drinks. Fruit culture until quite recently has received little or no attention as regards propagation, tillage, manuring, pruning, pests and diseases ; and it is too much to expect that any crop will improve under neglected conditions. A few residents however have taken a keen interest in the cultivation of fruit trees and special mention might be made of Mr. Tan Chye Siam of 60-2 Jervois Road, Singapore, as having had great success in the growing of oranges. The writer visited his orchard recently, and was much impressed with the results obtained. Seven years ago Mr. Tan Chye Siam commenced propagating the trees by marcottage from oranges grown in Singapore. The parent trees are of the ordinary type grown in this country but precaution was taken to select the best yielders and healthiest trees for marcotting purposes. The improvement of the stock is due to a number of factors. The mother plants were well cared for and the land maintained in a good state of tilth. Lalang and other noxious weeds were eradicated and the ground tilled periodically. The trees, therefore, were more suitable for propagation purposes than those growing under neglected conditions. The marcotted plants come into bearing in about three years ; this is a very much shorter period than that taken by seedlings to produce fruit ; soil conditions however appear to have considerable influence. The oranges now obtained are very different to those of the original stock. They are of the yellow type and, in size, are about equal to that of the best imported varieties. The flavour is good, although perhaps not up to the standard of first class oranges but considering the progress made in so short a time it is not improbable that ultimately the flavour will compare favourably with fruits grown in other countries. The oranges are very juicy and contain a small number of seeds. The plants are at present yielding an average of 200 catties of oranges per tree. There is a ready market for them and it is to be hoped that the industry may develop to such an extent as to render the importation of oranges unnecessary. The writer does not wish to be too optimistic as to the future of the crop but the results obtained in this orchard in Singapore are sufficiently promising to warrant the cultivation on a larger scale.

Marcotted plants, in limited numbers, can be obtained from Mr. Tan Chye Siam at a cost of $1/- each, exclusive of packing charges and freight.

A few general remarks on the cultivation of the orange may be of assistance to prospective growers.

As regards climate, the best results would no doubt be obtained on the hills. On the plains, the drier parts of the Peninsula are recommended. Heavy rains are detrimental to both the fruit, and the tree. The orchard requires to be sheltered from strong winds. The soil should be rich in plant food and frequent failure is due to unsuitable soil conditions. Trees grown under poor soil conditions are weakly and are subject to insect attacks and fungus diseases. The chief requirements of the orange tree are said to be lime and potash. In good soils, the trees may be planted at distances of fifteen or sixteen feet apart each way, the distance being slightly reduced in poor soils. Planting may be done during the wet season. The land requires to be dug over at least once a year, and frequent light tillage around the trees is recommended. The area should be kept free from lalang and other noxious weeds and every means taken to prevent surface wash. Green manuring is beneficial but the green matter must be incorporated in the soil periodically, at least round the trees, as tillage is essential.

Trees which are not thriving may be greatly improved by digging a trench around them and filling with a liberal supply of manure and good rich soil. The soil and manure must be well mixed previous to application. The circumference of the trench will, of course, depend on the size of the trees but a radius of 4 feet is regarded as a minimum distance. A top dressing of manure every year is greatly beneficial although, on first class land, manure may be applied at longer intervals. The manure is slightly turned under the surface, a matter of a few inches. Organic manure such as cattle, sheep, pig, night soil, leaves, etc. may be used—a sprinkling of wood ashes, lime and bone manure is of great benefit.

Oranges require little pruning except as regards the removal of superfluous, dead and broken branches.

A few growers, here, propagate the tree by marcottage and this is recommended. Budding and grafting are common methods of reproduction. Plants raised from seed are liable to produce fruits of a variable character.

The officers of the Department of Agriculture will be pleased to give growers every assistance.

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SPRAYING FOR CITRUS SCAB.

By A. Thompson.

IN view of recent attempts to establish lime cultivation on a commercial basis in Malaya the spraying experiments described below should be of interest.

Lime trees (*Citrus medica*, var. *acida*) are frequently attacked by a disease known as "Citrus Scab" which attacks the leaves and fruits. On the leaves it produces corky elevations on the upper surface, accompanied by corresponding depressions on the lower surface, and often so distorts and injures the leaves that they are prevented from functioning properly. The fruits when attacked become roughened and scabby and their market value is greatly reduced. Young nursery stock may become very stunted if attacked by scab and rendered useless for budding. The disease has been attributed to a fungus *Cladosporium citri* and occurs on lemon (*C. limonum*) Pomelo, shaddock (*C. decumana*), mandarin (*C. nobilis*), and other citrus fruits on which it causes scab of varying degree of severity.

The following is an abstract from a recent report on control o Citrus Scab in Porto Rico.*

> "Citrus Scab is the worst pest that the grower of citrus fruit has to contend with in Porto Rico. This disease, during the first years of the citrus industry, only attacked young trees, the old being immune. During the past few years this does not hold and many old trees that once bore fine fruit are now producing crops, practically worthless for shipping, that must be sold for canning purposes.
>
> A co-operative spraying experiment for Citrus Scab was started with one of our largest growers. The results of the first season's work is very encouraging. The season was exceptionally wet and the bloom extended over a prolonged period.

Four applications of Bordeaux oil were made to 3,000 trees which were being prepared for early fruit *i.e.* blossomings in December, January and February. The blossomings are not often heavy and as they come during our cold winter rains the fruit is liable to be very scabby. The first spray was applied on December 29th. The second on January 27th, the third on February 13th and the fourth on March 9th. Just prior to January 27th a second blossom appeared which set well. Following the February and March sprayings there was a flush and a blossom. The fruit which appeared after the last spraying with Bordeaux, was sprayed with lime and sulphur on March 25th. By this time the rust mites had made their appearance.

* Agric Extension Notes. Porto Rico Agri. Expt. Station. W. V. Tower, Jan. 1923.

The results in the six groves of 3,000 trees are as follows :—

	Per cent.
Clean fruit	94.4
Just a trace of scab	5.2
Slightly spotted with scabby areas ...	.4

Check trees (unsprayed) were selected in one of the worst infected groves on this property. These are at the foot of a cliff and do not get the early morning sun. The scab infection in these trees was as follows :—

	Per cent.
Clean fruit	10
Just a trace of scab	44.7
Slightly spotted with scabby areas ...	27.5
Very badly scabbed but not knotted ...	17.5
Knotted and covered with scab	0.3

Sprayed trees in the same grove showed the following :—

	Per cent.
Clean fruit	90.6
Just a trace of scab	9.3
Slightly spotted with scabby areas ...	0.1

Another grove on the same property was divided into three sections. One part was sprayed four times another part two times (Sic) and the remainder not sprayed. The results were as follows :—

	Sprayed four times. Per cent.	Sprayed two times (Sic) Per cent.	Not Sprayed Per cent.
Clean fruit	91.2	83.9	24.5
Just a trace of scab	8.8	15.0	37.5
Slightly spotted with scabby areas ...	—	0.6	24.5
Very badly scabbed but not knotted	—	0.5	13.0
Knotted and literally covered with scab	—	—	0.5

A grove of 900 trees was sprayed on January 13th with Bordeaux 3-4-50 and $\frac{1}{2}$% oil and again with the same formula on April 12th. These two applications were made before the spring blossom which occurred in May. The blossom was very heavy on May 11th and the grove was sprayed with lime-sulphur 1-30. The results were as follows :—

	Per cent.
Clean fruit	97.3
Just a trace of scab	2.4
Slightly spotted with scabby areas ...	0.3

Another grove of 800 trees which also blossomed late was treated as follows :—Sprayed April 5th with Bordeaux 3-4-50 and ½% oil and again on May 8th with same formula. The blossom commenced to come out on April 29th and on May 9th was heavy. The results showed :—

	Per cent.
Clean fruit	93.8
Just a trace of scab	6.0
Slightly spotted with scabby areas ...	0.2

The results obtained are very encouraging, but Bordeaux oil spray for scab must not be used unless the planter is willing to fight the scale which will surely follow, for all beneficial fungi, moss or lichen are killed.

This spray if applied haphazard will give poor results. Only the best spray materials should be used. A well planned campaign should be made and carried out. Be on the constant look out for scale and rust mites as these two pests come in very quickly after spraying with Bordeaux Oil. Plenty of material for fighting them should be on hand.

Recent tests with the Oil emulsion have been made at the station on grape fruit trees with fruits six months old. The solution has been used at the following strengths 1, 1-1½, 2-2½, and 3 per cent. of oil emulsion. There has been no dropping of leaves or burning of leaves or fruit.

In all the tests made with Bordeaux oil, using 3-4-50 Bordeaux with ½% oil there was a little burning of the young tender shoots. No small fruits or open blossoms were injured by this strength of spray. A few unopened blossom buds were burnt and dropped but no serious loss of leaves or blossoms was apparent.

If lime growers in Malaya ever embark on lime growing on an extensive scale there is every possibility of scab causing considerable trouble, but the success of the control measures recorded above is encouraging to those interested in this culture.

An account of the procedure to be adopted in making Bordeaux mixture is to be found in the *Agricultural Bulletin F.M.S., Vol. 1*, No. 11, 1913. To this mixture a good oil emulsion is added to make Bordeaux oil.

Spraying as above will assist in combating not only Scab, but also the other diseases of lime trees which are often serious, and which respond to Bordeaux treatment.

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SUMMARY OF OBSERVATION ON *Rhynchophorus schach*, OLIV.

THE "RED STRIPE" WEEVIL OF COCONUTS.

By G. H. Corbett and D. Ponniah.

GENERAL information concerning this insect in Malaya under the name of *Rhynchophorus schach*, Oliv. or *Rhynchophorus ferrugineus*, var. *schach*, Oliv. or "Red" weevil is available, but little detailed work has been published.

A study of this insect was commenced in 1920, and the principal observations made since that time are recorded in this "Summary of observations on *Rhynchophorus schach*." The details of the experiments will be published later in a Special Bulletin of the Department of Agriculture.

Rhynchophorus ferrugineus, Oliv. and *Rhynchophorus ferrugineus, var. schach*. Oliv.

Rhynchophorus ferrugineus, Oliv. is a reddish coloured weevil usually possessing black spots on its pronotum, but the insect found in Malaya is black with a red stripe on the pronotum. Dr. Guy A. K. Marshall has suggested that it would be wiser to treat the two forms as distinct species (viz :—*Rhynchophorus ferrugineus*, Oliv. and *Rhynchophorus schach*, Oliv.) until their specific identity has been definitely proved.

The two insects are so distinct in colouration that in future entomological writings in Malaya, *Rhynchophorus schach*, Oliv. will be referred to as the "Red Stripe" weevil and not as the "Red" weevil.

A number of variations of *Rhynchophorus schach* occurs in Malaya. The most commonly found variety has similar prothoracic characters to *Rhynchophorus schach*, but the elytra instead of being entirely black have reddish and black longitudinal markings.

Rhynchophorus schach is only found in Malaya, Sumatra and Borneo, *Rhynchophorus schach* and *Rhynchophorus ferrugineus* are both represented in Celebes, Java, and the Philippines, whilst in India, *Rhynchophorus ferrugineus* only occurs.

Nature and Indications of Damage to Coconut Palms.

This insect is injurious to coconut palms only in the larval stage. Soon after hatching the larva commences its operations and by gnawing and boring its way through the tissues may reach the very heart of the cabbage. The work is so rapid and the effect so deadly,

that these grubs are very much more dangerous to the life of the tree than is any other coconut insect.

In crown infection old and young trees are characterised by the falling down of the central shoots. Trees have been observed, in which the attacks of the "red stripe" weevil, as indicated by the presence of cocoons, have set up suitable conditions for the "black" beetle (*Oryctes rhinoceros*) to lay its eggs, although the old leaves were still greenish in colour.

In trunk infection there is frequently associated with the unhealthiness of the palm an exudation of a gummy nature, while at the same time discarded fibre often projects from the holes in the stem.

An attacked tree is occasionally detected by placing the ear against it when the gnawing of the grubs, if in sufficiently large numbers, may be heard.

The number of grubs in a tree varies considerably but it would appear that the female weevil having once found a suitable place for deposition does not go to many other suitable grounds farther removed. In the top of a "rembia" palm as many as 150 larvae have been counted, and in a coconut palm 76 cocoons have been noted. It should be mentioned, however, that probably more than one weevil was attracted for egg laying.

Relation between the "Red Stripe" Weevil and the "Rhinoceros" or "Black" Beetle. (Oryctes rhinoceros, Linn.)

Rhynchophorus schach occasionally takes advantage of the borings into the crowns of coconut palms made by *Oryctes rhinoceros*, Linn. for egg laying. It is not implied that all, or by any means nearly all, coconut palms attacked by "black" beetles are visited by *Rhynchophorus schach*, but when the crowns are injured by the "black" beetle, conditions attractive to the "red stripe" weevil are set up.

The chief reasons why coconut trees damaged by *Oryctes rhinoceros* are often not attacked by *Rhynchophorus schach* are :—

(1) The absence of the "red stripe" weevil in the district. On the sides of new clearings where conditions are frequently suitable for the breeding of both beetles, because sufficient precautions have not been taken while burning off the jungle to destroy completely all sago, "serdang", "nibong", and other palms, young coconut palms frequently show signs of attack by the "black" beetle, yet no loss has been occasioned by the "red stripe" weevil. Indications that coconut palms have been attacked by the "black" beetle may be seen daily, but the "red stripe" weevil has not followed.

(2) The presence of other suitable breeding material. There is no doubt that the "red stripe" weevil prefers other injured palms to coconut and in a district where there is an accumulation of material

of some other palm, e.g. sago, attacks on coconut trees by this insect are not so numerous.

(3) The individuals of *Oryctes rhinoceros* are more numerous than those of *Rhynchophorus schach* and therefore probably more trees are liable to be damaged by the former than the latter.

Enormous damage can be done by the adults of the "black" beetle and by the grubs of the "red stripe" weevil, but the former insect rarely kills the trees. Damage by the latter is often fatal especially as the damaged palm frequently attracts other weevils for egg-laying. One grub of the "red stripe" weevil may cause the death of a palm if it damages the bud; in fact, in an experiment where the grub had bored through the base of the bud, the bud was killed primarily on account of this injury.

Relation between Fungus and Bacterial Diseases of Palms and *Rhynchophorus schach*, Oliv.

Weevils coming from a diseased tree may be carriers of fungus or bacterial diseases to palms only if the conditions there are suitable for egg-laying, e.g. after injury to palms caused by the "black" beetle, and the grubs may provide a means of entry for diseases.

Since, as will be shown later, weevils are not considered to visit undamaged trees, there seems little danger of their acting as carriers of infection from diseased trees.

Host Plants of *Rhynchophorus schach*, Oliv.

Besides the coconut palm (*Cocos nucifera*), the following palms have been found suitable for the development of this insect:—

Sago (*Metroxylon sagu*); Sugar or Kabong (*Arenga saccharifera*); African oil (*Elaeis guineensis*); Serdang (*Livistonia cochinchinensis*); Nibong (*Oncosperma tigillaria*); Areca or Betel nut (*Areca catechu*); Royal (*Oreodoxa regia*); Gebong (*Corypha genbaga*); and Bagas (*Oncosperma horrida*).

In India, *Rhynchophorus ferrugineus* has been reported from the Date Palm (*Phoenix sylvestris*) and Palmyra or Toddy palms (*Boraseus flabellifer*).

General Life History.

The eggs, which may be laid in any damaged portion of a palm, hatch in about 3 days to whitish legless wrinkled grubs. The larvae feed inside on the tissue of the palm and when full grown make cocoons of fibres. Inside the cocoons they change to pupae from which adults emerge.

(1) Egg. Method of Egg-laying.

The method of egg laying was observed on a number of occasions. The female weevil at first tries by means of its antennae and rostrum to find a suitable place for the deposition of the egg. Having found a convenient spot, she bores a hole in the wood with her snout. This action is aided by a backwards and forwards rocking movement. The snout is inserted usually as far as the base of the antennae but occasionally as far as the funiculus. The hole is made slightly larger in diameter than the breadth of the egg, and frequently the rostrum is withdrawn and inserted again so as to increase the size of the hole. The hole is straight at its commencement but the base is slightly curved so that in shape it is similar to the snout of the female. The female having completed the hole to her satisfaction, in the majority of cases observed, turns round and after finding the hole with her ovipositor deposits an egg. Only very occasionally is the hole not found and too small to receive the egg. If the egg is deposited on the surface or partially exposed above the opening, the female breaks the egg and completely consumes its contents together with the egg shell. The egg inside the hole has never been found damaged.

The hole is always cemented after egg laying by a pinkish substance having a definite structure. Examined under a lens the plug is cup-like in shape with a dividing piece—broader at one end than the other—across the centre, and placed with the concavity towards the surface of the hole. Two small holes in the blunt end may be followed through the plug and appear enlarged on each side of the partition. This plug is placed 1 millimetre above the egg and is probably a protection against egg parasites, but on account of the difficulty of finding the egg in nature no definite information on this point has been obtained. Eggs laid in breeding cages were deposited at any angle. At the end of the wood they were usually parallel to the fibres; in the wood, parallel, oblique, or perpendicular.

The broader end of the egg is always situated at the base of the hole previously made by the female weevil. The hole varies from 3 to 8 millimetres in depth, but is usually about 5 millimetres.

Egg laying takes place as much by day as by night. In an experiment 401 eggs were laid between the hours of 6 a.m. and 6 p.m. and 428 between 6 p.m. and 6 a.m. This is remarkable as, judging by the hours during which weevils were attracted to traps, they are not active fliers by night. The weevils noticed in the field at night are decidedly inactive and when thrown in the air make no attempt to fly, in fact they usually try to bury themselves in the grass or to find any convenient dark place. Weevils found on trees at night are closely 'adhering' to the trunk and at least, on the African oil palm, appear to prefer places of concealment.

Places of Egg Deposition.

Considerable doubt exists concerning the places where eggs are deposited by the "red stripe" weevil in coconut palms, and a most debatable subject has been the capability or otherwise of this weevil

to lay its eggs in sound trees. Since there is discrepancy amongst accounts, experiments were commenced to ascertain, in the first place, if adults could lay eggs in sound trees.

The result of these experiments showed that weevils were unable to lay their eggs in the crowns or at the bases of leaf petioles of coconut palms unless previously damaged.

Further experiments showed that weevils were unable to lay their eggs in the unbroken stems of coconut palms, but could deposit them in wounded stems.

Series of experiments were undertaken to find out if larvae, after being placed in holes at different heights in palms of various ages, could penetrate the tissue of the palm. These series represented eightyone occasions when eggs or grubs were placed in separate holes to a depth of 1 to 1½ inches at different positions of the trunks in palms varying in age from 3 to 14 years of age. Only on two occasions after examination at the base of a palm 10 years of age were live grubs found. No penetration towards the centre of the palm was, however, noticed. The grubs were working on the soft portion of the rind which was rather wide at the base in this particular tree.

The results from these experiments are entirely different from those expected. The hard freshly exposed cylinder of vascular bundles immediately below the rind, being compact and dry, seems to act as a barrier to the successful ingress and feeding of the larva. The rind varies in thickness from one tree to another and is narrower at the top than at the base. In a number of cases, eggs and grubs were placed in the hard freshly exposed area of vascular bundles and the young larvae, from the eggs and those introduced, not being in close proximity with succulent food material, were unable to live.

The result of an experiment conducted by placing one day old grubs near the base and in the centre of a palm about 25 years of age indicated that if the interior of coconut palms up to 25 years of age is exposed the tissue provides suitable material for the development of the grubs.

From the results of these experiments, grubs of the " red stripe " weevil entering the palm through toddy steps should not occur so long as the steps are not cut more than 1" deep or through the compact tissue. This should be kept in mind when making cuts near the crown of the tree, but since toddy steps are not necessarily required in such positions there is little need for this warning.

Further experiments were conducted to find out the advisability of cutting or pulling the leaves off coconut trees by placing one-day old grubs in the cut ends of petioles at various distances from the trunk. The tissue of the leaf petiole was found to provide suitable food material in so far that grubs successfully reached the adult stage in this material and a grub penetrated the trunk of a palm after having previously eaten through 36 inches of petiole tissue.

In conjunction with the success obtained from these experiments it should be mentioned that cocoons and feeding galleries of the grubs of the " red stripe " weevil are frequently found on leaf bases and that a female was observed in nature to lay an egg in the cut end of a petiole of an African oil palm, so that pulling or cutting the leaves of coconut palms should not be practised.

(2) The Larva.

The larva or grub causes the damage to coconut trees. When the eggs hatch out, the grubs are in close proximity to their food and as they grow the feeding galleries increase in size.

Larvae about the same or of different ages may be found together in an attacked coconut palm ; frequently full grown larvae, cocoons, and adults are found together and in such cases very young larvae are usually not present. This is to a certain extent explained by the fact that the palm being in a more or less rotten condition has lost its attractive power for egg laying weevils.

The larvae shun light. This was often noticed in breeding cages where larvae, having eaten down to about 1" of the bases of logs of palm wood, turned and tunnelled in an upward direction.

The larvae prefer moist and young succulent palm wood, and some species of palms to others. The following palms are considered in order of decreasing suitability for the development of the larva. Sago (*Metroxylon sagu*) ; Nibong (*Oncosperma tigillaria*) ; Coconut (*Cocos nucifera*) ; African oil (*Elaeis guineensis*) ; Sugar or Kabong (*Arenga saccharifera*) ; and Areca or Betel (*Areca catechu*).

The grub does not feed on the longitudinal fibres. The fibres, having been cut through and the soft succulent tissue eaten, are collected and passed by peristaltic movements beneath the grub's body to the rear of the tunnel.

The greatest distance tunnelled by a larva through a nibong palm was 6 feet 8 inches in 56 days.

Grubs submerged in water for three days died.

Moulting.

Prior to moulting grubs do not feed. This indicated a cast skin would probably be found on the following day. In each moulting operation observed, the skin split along the dorsal line generally as far as the third segment and the grub came through the rupture by gradually working the old larval skin backwards. The newly emerged larva including the head and first thoracic segment is creamy white in colour with the exception of the darkish coloured mandibles. In about an hour the general colour of the larva is assumed.

The minimum number of moults found for the larva was 16 and the maximum 20.

(3) Pupa.

After making its cocoon the larva is quiescent. Gradual shrinking takes place and a few days prior to pupation the larva assumes a distinct inactive larval form. In this stage, the ventral surface is very much flattened and the segments are more pronounced. When disturbed the prepupa does not crawl but wriggles—a habit usually associated with the pupa. After this stage, there are definite pupal and inactive weevil stages in the cocoon.

In order to find out the length of time occupied by the various stages in the cocoon, a number of full grown grubs was collected and the dates on which the cocoons were completed were noticed. The cocoons were slightly cut in the middle so as to observe the changes, secured to prevent weevils emerging through the openings, and kept on damp chips of palm wood.

The following results were obtained by observing the changes in the cocoons treated in the above manner :—

From 2 to 4 days were passed before the larva assumed the inactive form, the inactive larval stage occupied 3 to 7 days, the pupal stage from 11 to 15 days, and the inactive weevil stage from 10 to 15 days, making the time passed in the cocoon vary from 26 to 41 days.

(4) Weevil.

Weevils require food : when deprived of food they died in from 3 to 7 days. The maximum length of life found for the female was 116 days and for the male 107 days. The maximum number of eggs laid during the life of a female was 832, by an individual in one day was 35 but the average daily number of eggs was 7.7.

The weevils are very strong fliers and have been recorded flying 900 metres. The distance travelled has an important bearing on the destruction of breeding places not far removed from coconut plantations : the sanitation of such places as "rembia" clumps for the control of this insect is essential.

Trapping.

Coconut and other palm wood attracts " red stripe " weevil and in order to obtain definite information, concerning the advisability of recommending the employment of traps, experiments with several species of palm, split and cut into suitable lengths—about 1 metre—were conducted.

The number of weevils caught by the employment of traps composed of different species of palm was far smaller than was expected. The variation in the trapping experiments conducted at Tampin, and at Kuala Lumpur, might be explained by one site possessing less attraction than the other, owing to the proximity of suitable breeding material near the less successful site.

The traps were composed of the following palms: nibong, areca, coconut, sugar, and sago. In traps composed of sugar and coconut palms, no weevils were collected, though, under natural conditions, the larvae of this weevil have frequently been found in these palms. To some of the traps consisting of areca, nibong, and sago palms, weevils were attracted,

From the results of the experiments and from general observations both nibong and sago palms are considered to possess greater powers of attraction than either coconut, sugar, or areca palms.

When Sago palm traps had a fresh surface exposed every day the attraction seemed to be greater.

Weevils were attracted on the second day and continued to be until the sixteenth day after the surface of the palm was exposed.

The weevils commenced flying after six in the morning and continued throughout the day. They appeared to be more active between the hours of 6 and 9 than at any other time, gradually decreasing in their activity towards evening.

Forty-four females and thirty-four males were caught at the traps showing that the sexes were attracted in about equal proporitions.

Conclusion.

Trapping "red stripe" weevils cannot be recommended as a general practice, though, if coconut trees are frequently killed by this insect and if nibong or especially sago palms are easily obtained, a system of trapping may be of considerable value in reducing the numbers in the area. The traps should be visited frequently during the day time and the weevils collected and destroyed.

Weevils visiting Healthy Palms.

In discussing the "Relation between Fungus and Bacterial Diseases of Palms and *Rhynchophorus schach*, Oliv" the statement that there seems little danger of weevils acting as carriers of infection from diseased trees to undamaged trees was based on the results obtained from the Trap Experiments. Weevils were not caught at any trap either on the day or on the day following the palms being felled, and for that reason it is considered that they would not visit uninjured palms.

Burying the various stages of Rhynchophorus schach.

Weevils buried 3 feet deep were found capable of finding their way to the surface of the soil.

Well developed grubs in palm wood buried 3 feet deep reached maturity and the weevils came to the surface of the soil.

Nibong logs containing 3-day old grubs were buried 3 feet deep and after 3 months examined. Though only two undergrown grubs were found, there is little doubt they would have reached maturity and the adults emerged through the soil.

From the results of the experiments on burying, burying coconut logs containing eggs, grubs, or adults is not recommended.

Further investigations demonstrated that weevils, although they are able to come through 3" of soil, cannot lay eggs in palm wood covered over with only 1" of sand.

The disposal of palms, though containing no eggs, by covering them over with a layer of sand is inadvisable owing to the constant supervision necessary to prevent the wood becoming again exposed, especially in Malaya where heavy storms are liable to wash the sand off the buried palms.

Life Cycle.

Considerable work has been done in order to find out the length of time taken for *Rhynchophorus schach*, Oilv. after emerging from the cocoon to complete its life cycle, and as a result of these investigations the following minimum figures have been obtained.

o	Egg Stage	3 days.
x	Larval Stage	59 ,,
x	Cocoon Stage	25 ,,

o The majority of eggs actually hatched in just under 3 days.

x The aggregate number of days for both larval and cocoon stages found was 84 days and the shortest time for the cocoon stage 25 days making 59 days for the larval stage.

In this connection mention should be made that the preoviposition period—the time elapsing before the newly emerged weevil from the cocoon commences to lay eggs—varies from 1 to 6 days.

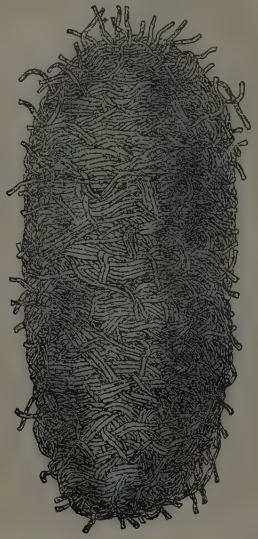
Since the " red stripe " weevil can complete its life cycle under 3 months, it is clearly essential to destroy dead palms and palm refuse before that time in order to prevent palms from acting as breeding grounds for this insect.

Control.

Though information will have been gathered concerning the control of this insect by the perusal of the previous pages in this " Summary of Observations on *Rhynchophorus schach* " the subject may be briefly considered under the headings of Precautionary and Remedial Measures.

RED STRIPE WEEVIL.

~~RED WEEVIL~~



1 2 3 4 5

T. De La Mare Morris

1. Egg 2. Larva 3. Pupa 4. Cocoon 5. Adult

(I) Precautionary Measures.

Before the presence of the grubs of this insect becomes evident, the palm might have suffered irremediable damage, so that every precautionary endeavour should be taken.

Injury to coconut palms may be caused by (a) Insects (e.g. *Coptotermes gestroi* and *Oryctes rhinoceros*), and their control may be effective in preventing *Rhynchophorus schach*, attacking the palms. (b) Lightning and Storms. Trees which have suffered through the agencies of lightning and storms and are afterwards attacked by the "red stripe" weevil would in most cases be better destroyed, and (c), Man, by cutting steps and cutting and pulling off leaves or spikes. All wounds should be tarred at least twice, as after tarring once the surfaces are liable to become exposed again.

The prompt and thorough use of fire for the disposal of dead or decaying palms is advocated. Burying under ground is not recommended.

(3) Traps may be employed if material is available and the weevils can be regularly collected.

(4) "Red Stripe" weevils are occasionally found in the holes of *Oryctes rhinoceros* and regular collection of the latter will help in reducing the number of the former.

(II) Remedial Measures.

If the larvae destroy the growing point, which is unusual, the trees will die. The palms may escape the first attack with less than fatal injury but they will be more prone to subsequent attacks, and for sometime will be less productive. Again, weevils emerging from such attacked trees may go to other trees with the result that the attempt to save one tree may cause the destruction of several others. The wisest policy to adopt is to destroy a tree with crown infection, as soon as it is known to be infected by the "red stripe" weevil.

With trunk and root infection, a tree may sometimes be saved by removing the larvae, cutting away the diseased tissue, and disinfecting the exposed surfaces to arrest further decay. Only diseased tissue should be removed; it is unnecessary to weaken the tree by cutting away healthy wood. The cavity should be made as smooth as possible with its base sloping so as to prevent rain from lodging, disinfected thoroughly and watched for further signs of disease. The palm may be allowed to stand without further treatment but filling the cavity, especially if large, with cement might be undertaken. If the operation of cementing is performed it should be done slowly and allowance for drainage made. If the cavities are small, the resulting benefit might repay treament, but if large the cost of treating the attacked tree together with the risk that it may eventually be blown down, or that the disease may not be properly arrested from the first, would probably render unprofitable such a remedial measure.

Received for publication March 29th 1923.

REPORT ON THE WORK OF THE INSPECTION STAFF, OCTOBER 1 TO DECEMBER 31, 1922.

By F. W. South.

I. Staff Changes.

THE services of the two Special Field Officers in Negri Sembilan, engaged on the control of Mouldy Rot disease in Rembau sub-district and around Rantau, were terminated on November 30th, when the work was left in the hands of the normal staff. As a result of examinations held in November certain Malay Officers received promotion at the end of the quarter.

II. Diseases and Pests of Rubber.

Pink Disease (*Corticium salmonicolor*). This disease was newly reported on one estate in Selangor and on two in Johore. It was found for the first time in the North West corner of Penang Island, about 9 cases occurring on a small estate. No other cases in the neighbourhood were found. This is the second occasion on which Pink Disease has been reported in Penang. In other parts of the country the disease became rather more prevalent with the advent of the rainy weather; treatment was, however, steadily enforced and the situation calls for no comment.

Mouldy Rot. (*Sphaeronema fimbriatum*). This disease was newly reported on one estate in Perak North, two estates in Selangor and five in Negri Sembilan. On December 14th a report was received by the Assistant Agricultural Inspector, Perak North that mouldy rot disease had appeared in the neighbourhood of Padang Rengas, near Kuala Kangsar. Investigation showed that an estate and some 3-4,000 acres of small holdings were affected. Control measures were very promptly instituted and have been carried out satisfactorily in the main. Attempts to restrict the disease to the one area and to control it within the area are still in progress. It seems very probable that the disease was carried into Perak, where it has been previously unknown, by wandering tappers, Banjaris or Javanese.

During October the expected spread of the disease to Selangor occurred; it was discovered at Sepang where about 3 square miles of small holdings were found to have been infected for some weeks. This outbreak was probably introduced by tappers from the neighbouring mukim of Chuah in Negri Sembilan where the disease is present. The treatment of the disease was demonstrated by the Assistant Agricultural Inspector, Selangor, with the result that all but 5 small holders treated the disease satisfactorily. The few offenders were summoned and fined. The outbreak had been practically entirely overcome by the end of the year.

During November and December the disease also appeared on two estates in Ulu Langat district on the Selangor-Negri Sembilan boundary. In both cases the disease was promptly and effectively treated. No small holdings were found to be infected in this area.

In Negri Sembilan the disease has spread northward as far as the Selangor boundary at Batang Benar, but its treatment everywhere is being steadily enforced. As usual wet weather has rendered it more prevalent.

In Malacca this disease, which was found in two new areas during the third quarter, was in this last quarter found in a fourth locality, namely near Chin Chin in the Southern district not far from the Johore boundary. Energetic measures have been taken to confine the disease to the few holdings infected in this area. In the Sungei Rambai-Sebatu area the spread of the disease has been aided by wet weather and difficulty is being experienced in enforcing the proper control measures among the owners of the holdings, who are for the most part Chinese. The cessation of tapping is essential and in this lies, as usual, the main difficulty.

Wet weather has been responsible for a rapid development of the disease in Johore. The centres of infection remain the same, namely from Batu Pahat to the Muar district boundary, around Muar and Panchor, and between Batu Anam and Labis on the railway line. The swampy land in Batu Pahat and Muar districts, covered as it is with somewhat neglected rubber trees, offers conditions for the spread of a fungus such as this, which render control a matter of extreme difficulty.

Black Stripe (*Phytophthora* sp.) This disease was newly reported from one estate in Johore where it received prompt treatment. A new small area of infection was found in the Kuala Pilah district of Negri Sembilan.

Fomes lignosus. There is no doubt that certain cover crops help the spread of this fungus. The investigations of the Assistant Agricultural Inspector, Perak North, show that the method of counting stumps on young clearings showing fructifications of this fungus at one time gives no indication of the number of stumps affected, because the fruits develop irregularly on different stumps and disappear rather quickly, so that they can easily be missed ; while some infected stumps may not develop fruits of the fungus for some time. However, if care is exercised the advantages of cover crops outweigh the disadvantage due to the spread of *Fomes lignosus.*

No other diseases of rubber call for special comment.

III. Coconut Diseases and Pests.

Beetles. Good progress has been made with the work of destroying the breeding grounds of the black beetle and the red stripe weevil, especially all through the Colony and in Selangor. In Johore the destruction of refuse in which the black beetle breeds is receiving

attention, though suitable decaying refuse is still very common in some parts of the State.

Nettle caterpillars (*Thosea* sp.). The caterpillars of this insect did considerable damage to 10 or 15 acres of coconuts at Sungei Batu in the Balik Pulau district of Penang. The attack is reported to have started at the beginning of September, but it was not discovered until the middle of October by which time only pupal cases of the insects could be found. The Malays on their own initiative had lighted smoke fires under the trees and had poured Brunolinum on these, their aim being, apparently, to form a suffocating cloud which would cause the caterpillars to fall to the ground where they could be collected by hand, eaten by fowls, or otherwise destroyed. It is uncertain to what extent this was effective.

Brachartona catoxantha.—An outbreak of this pest occurred at the 6th mile Kuala Selangor-Bernam Road at the beginning of the quarter The outbreak was slight, and disappeared rapidly, thanks to crows and heavy rain.

Grasshoppers. (*Orthocanthacris nigricornis* and others). Some damage was done to young coconut-trees in Sepang Mukim of Selangor in November and December by semi-swarming grasshoppers, chiefly of the species named.

Plesispa reichii.—An attack of this beetle was reported on a small coconut holding in Kuantan district of Pahang.

IV. Padi Pests.

Nymphula depunctalis.—The control measures carried out at Matang have been effective and the padi there is not only free from this particular pest, but is freer from pests in general than it was last year. This may be partly due to different weather conditions, but it is also partly due to the control measures described in my last report.

Leptocorisa spp.—This pest occurred to a slight extent in various localities throughout the Federated Malay States and the Colony, but on the whole did very little damage. It is known by the Malays in Province Wellesley as "Chenanggong" and in most other parts of the Peninsula as "Pianggang."

Other pests recorded as present to a slight extent were *Nephotetix bipunctatus* ("Benah") together with an insect very near *Tettigoniella spectra* and an unidentified stem borer, in Province Wellesley; with *Podops coarctata* ("Benah Kura" or "Kutu Bruang") to a slight extent in Kuantan district and more seriously in one locality in Johore.

These pests are additional to those mentioned in my last report; on the whole, however, the padi everywhere has been singularly free of all pests other than rats.

Rats.—Before the end of the quarter the full stock of ½ ton of barium carbonate had been distributed. A further supply had been ordered by cable, but had not arrived by the end of the year. The Malays appear thoroughly to appreciate the opportunity of purchasing this poison at cost price *i.e.* one cent per oz., and it will be advisable to supply larger stocks in the coming year.

The poison seems on the whole to have worked efficiently. There was a complaint that part of the supply was not satisfactory from one district in Selangor, while in Negri Sembilan the Malays consider that barium carbonate is effective against the small rat, but not so effective against the large rat, "Tikus mondok." Reports from Malacca are variable, but success has usually followed when the baits have been properly prepared and used. Heavy rains occasionally render it useless by washing away baits. It is difficult to determine its efficiency exactly, as dead rats are not often found, they die in their holes or in water. Malays are liable to doubt the efficiency of the poison, if no dead rats are found, but, on the whole, judging by the demand, the sale of supplies at cost price has been successful.

Traps have given good results at the Experiment Station in Malacca this year and in other localities in the past and should be used to supplement the poison. It may be possible to stock traps and sell them at cost price in the coming year.

V. Lalang and Blukar.

It is hoped that the rise in the price of rubber during this quarter will induce small holders to clean up their land to some extent; if no action is taken the greater prosperity of the owners will justify the Inspecting Officers in insisting on the cleaning up of holdings in the coming year.

There is much evidence to show that giant mimosa, *Mimosa invisa*, can kill lalang. It is necessary to ascertain how long the cover must be present to eradicate the lalang completely and experiments will be started to decide this. In the meantime it is proposed to try using Giant Mimosa to destroy lalang on certain holdings in Perak North, in order to demonstrate the cost of planting it, to test its suitability on small holdings and to show its effect. The principal danger is that, if neglected on a holding with young trees, it would itself smother the rubber trees.

VI. Water Hyacinth.

In Province Wellesley useful work has been done by the Public Works Department at the request of the Assistant Agricultural Inspector in clearing the drains in the Sungei Acheh district of this pest. Further work remains to be done in the coming year.

In Perak North the regular cooly gang carried out routine work in Krian district, while in Perak South during the quarter several tributaries of the Perak River were cleared of the weed and State land at Kampar was cleaned. In Selangor and Negri Sembilan a few patches found have been removed.

VII. Pests and Diseases of Other Crops.

Achatina fulica.—The Assistant Agricultural Inspector, Penang and Province Wellesley, reports that the giant snail is still to be found in small numbers, but causes little anxiety, and that he is of the opinion that it is gradually becoming extinct. This is partly due to control measures and partly to the unsuitability of the surroundings.

Collections are being made for study by the Entomologist and the Mycologist of the diseases and pests found on, and frequently common to, Roselle, cotton and silk cotton (Kabu Kabu). On Roselle and cotton pests are rather numerous.

Specimens of pests and diseases on minor crops have also been collected and forwarded for record and identification in considerable numbers, notably on citrus plants which, as in some other countries, seem very liable to insect attacks.

Giant Mimosa suffered some damage on an estate in Selangor, where it was growing as a cover crop, owing to the attack of semi-swarming grasshoppers. The attack was not serious, but efforts have been made to destroy the insects with poison.

VIII. General Agriculture.

1. *Rubber.*—With the report in October that restriction of output would be introduced the price of rubber commenced to rise. As restriction became an accomplished fact in November, the rise continued until the end of the year when the price reached 50 cents per lb. in Singapore.

As a result the Assistant Agricultural Inspector, Penang and Province Wellesley, records that a number of small holders have recommenced tapping their trees, while others appear to be adopting a more drastic system of tapping. In some parts small holders are selling their coupons instead of tapping. The prices of coupons in Selangor at the end of the year were said to be $30 to $35 per pikul coupon. Dealers are purchasing at a low price a considerable quantity of rubber not covered by coupons.

In connection with restriction the Chief Agricultural Inspector was invited in December to serve on a Committee to consider the incidence of the scale of production allowed by the rules on young estates.

Interest in bud-grafting is being maintained among planters.

2. *Coconuts.*—There is nothing calling for record, beyond the fact that the price of copra fell during the quarter to little over $9 per pikul.

Padi.—In Penang, Province Wellesley and Perak conditions have been favourable to the padi crop on the whole and in most districts a good crop is anticipated, this is especially the case in the Province where reaping had commenced at the end of the quarter. In Krian and in Larut districts the crop is late.

In Kuantan district of Pahang a better crop is expected than was reaped last year.

In Negri Sembilan the padi crop harvested in Kuala Pilah and Seremban districts was largely spoiled by the heavy rains usual at the time of year. The Assistant Agricultural Inspector, therefore, suggests that an improvement might result from a change in the planting season in such localities. The result of the harvest in Jelebu district, expected in February and March next, will form an interesting comparison with that of the earlier areas.

In Johore padi growing is as yet carried on only in a very small way. There are large areas of suitable land in the State and the Assistant Agricultural Inspector is endeavouring to give every assistance to the present cultivators in the hope of affecting improvements and stimulating padi planting. That padi can be grown successfully is shewn by the fact that an average yield of 450 gantangs per acre is obtained in Kota Tinggi district.

The testing stations at Permatang To Gelam in the Province and at Talang near Kuala Kangsar give promise of good yields. The Experiment Station in Malacca will be a failure this year, owing to the fact that the water supply could not be controlled, as the expected facilities were not available this season.

The pure strains of padi distributed in the Province and in parts of Perak are favourably reported on.

The Assistant Agricultural Inspector, Penang and Province Wellesley, has been informed that a Siamese vendor of seed padi toured the Province this season. The Assistant Agricultural Inspector has seen crops grown from this seed and states that they show every promise of even ripening and a heavy yield.

Investigation have been commenced to ascertain, if possible, why certain bendangs in Kuala Kangsar have given very poor crops of late, whereas they yielded good padi crops some years ago. A good deal of work is anticipated before definite causes can be assigned or definite recommendations be made.

Permission has been obtained to commence some experiments on old dredged mining land with the object of converting it into good padi land. Two companies near Taiping have kindly placed land at the disposal of the Department. One plot is fenced and the other will be in the near future. The plots will be planted up with leguminous crops at the earliest opportunity. Planting has been delayed by the work entailed in controlling the outbreak of Mouldy Rot at Padang Renggas.

Fruit.—Durians in Province Wellesley and Penang were not so plentiful as in the previous season of this year.

Pineapples. Tan Kah Kee's pineapple canning factory at Klang is now open, and producing 20,000 tins (1½ lb.) of cubes or slices daily. The fruit is graded into three qualities selling at $7, $6½, and $6 per case of 48 tins locally. Most of the output is sold in London Liverpool or New York. The price of pineapples at the door of the factory is 2½ cents.

A small factory was opened in the Province in August, but had to close during the quarter as the price of canned fruit fell from $10.50 to $5.50 per case, so that the production costs were not covered.

There is a considerable area of this fruit grown in Southern Johore for canning and three factories are working near Johore Bahru. A small factory is also operating at Kota Tinggi where the cultivation of pineapples is increasing.

Other Crops.—Roselle. A Chinese farmer has been granted the lease of a piece of land near the District Officer's house at Balik Pulau, Penang to grow roselle. This will serve as a demonstration plot.

In Perak South the four demonstration plots in Kinta district have not proved successful, the cause is not clear.

In Selangor the demonstration plot at Tanjong Malim has not proved a success; but that at Batang Kali is progressing well. It is proposed to start 3 plots in Klang district in January 1923.

In Kuantan the Malays have tested locally prepared samples of the fibre and consider it insufficiently strong to be worth planting. I do not understand the reason for this, as the fibre should not be weak.

Enquiries for seed have been received in Negri Sembilan, but the high price of it has deterred possible planters.

The Assistant Agricultural Inspector, Penang and Province Wellesley, records that Chinese near Bukit Mertajam have between 30 and 40 acres of padi land under cultivation of "Ubi Keladi" or "Keladi Chabang." This vegetable is popular with the Chinese and some of it is exported to Perak.

The Assistant Agricultural Inspector, Negri Sembilan, records an application for 10 acres of land for planting Egyptian Cotton. He also notes that a few Chinese vegetable gardeners are planting fruit trees, mostly citrus, in their gardens.

IX. Instructional.

A conference of Malay Officers of the Department was held in Kuala Lumpur on November 20, 21 and 22. The proceedings

included several papers on Co-operation and a visit to Serdang Experimental plantation.

Departmental Examinations were held immediately after the Conference for promotion to the grades of Senior Agricultural Assistant and Junior Agricultural Assistant.

X. General.

The Chief Agricultural Inspector assisted to revise various rules for the importation of plants into the Straits Settlements and Federated Malay States.

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NOTE ON BREEDING-GROUNDS OF THE BLACK (RHINOCEROS) BEETLE, *(Oryctes rhinoceros.)*

By G. E. Mann.

THE customary breeding-grounds of the black beetle, viz. decaying cattle-manure or vegetable refuse, are in most cases easily discovered. Two recent experiences, however, illustrate the necessity of being prepared to find such breeding-grounds in unusual circumstances.

In one case, an 8 acre coconut holding was found to have been badly attacked by beetles, but the Malay Inspector had failed to find more than one small breeding-ground, which consisted of decaying leaves and petioles. On further examination, however, it was noticed that the trees had been burned at the base, and that the ash from the burnt rubbish had been heaped round each tree. A casual observer would have thought these heaps to have been completely burnt, as they were quite powdery; but, on opening them up, over 200 heaps were found to be infected, and some 4,800 grubs of the black beetle were collected and destroyed.

In the second case, a few trees were found to have been attacked, but no decaying vegetable matter was discovered until the premises of a Chinese pig-rearer were entered. Several decaying trunks of Kabong (sugar palm), used as a pig-food, were then found to contain grubs.

These two experiences demonstrate clearly the possibility that many breeding-grounds may escape detection unless a detailed inspection is made over the whole area in which grubs may be found, *i.e.* within 400 yards in all directions from the infected trees.

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THE FLOWER AND THE BEE.

VERY IMPORTANT LINK IN EVOLUTION.

By Professor J. Arthur Thomson.

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ONE of the main trends of evolution has certainly been to link living creatures together, and one of the most important linkages in history has been that between flowers and useful insect visitors, such as bees. Useful because the bees, in getting pollen and nectar for their own purposes, bring about the cross-fertilization of flowers. And this cross fertilization improves both the quantity and the quality of the seed. Throughout long ages the flowers and the bees if we may keep to bees for a moment, have evolved together, and they are now fitted to one another as hand to glove. In many cases they are nowadays indispensable to one another, for many of the flowers are so specialized that they cannot be fertilized except by bees; while, on the other side, bees are so highly specialized that they would all come to an end if there were no flowers that produced nectar.

Virgin-Birth.

This linkage, like many another, must in some measures determine the lines of further evolution; for the flower cannot safely change in a direction that would shut the door on its visitors; and the bees cannot safely change in a direction that would lessen their success with the flowers. The linkage is part of the well-woven web of life, and it tends, like social linkages of a profitable kind, to keep things from sliding back. One must be cautious, however, for it is possible that without insects to pollinate them flowers might fall back on virgin birth (or parthenogenesis) and that seems to be occuring in such very successful flowers as dandelions. They still produce pollen, but it is not used.

Bees as "Good Botanists."

Inside the seed-box of a flower there are possible seeds or ovules, each containing a single microscopic egg-cell. The possible seed will not become a real seed that is to say, an embryo plant, unless this egg-cell is fertilized. Similarly, no one expects a chick to come out of the unfertilized egg of a hen, and the egg must remain unfertilized if there is no cock in the yard. The fertilization of the microscopic egg-cell of the plant depends on the dusting of the tip or stigma of the pistil with appropriate pollen-grains produced by the stamens of another flower of the same kind. Cases of self pollination, as in peas, oats rice, are in a minority; in most cases the pollen is carried from another blossom by insects or by the wind. A suitable pollen-grain, caught on the moist surface of the stigma, sends out a long

tube which grows down to the ovule, and a male element—little more than one of the nuclei—in the pollen-tube enters into intimate orderly union with the microscopic egg-cell. In the maidenhair tree and a few other primative seed-plants the male element is a freely moving cell, as it is in mosses and ferns and in most animals. In all ordinary flowering plants the male element is a more or less passive cell borne to the egg-cell by the growth of the pollen-tube. But in all cases the essence of fertilization is the same, the intimate union of male-cell and egg-cell: this is the beginning of a new individual.

But this is only an introduction to what we wish to get at—namely, an answer to the difficulty which must rise in the inquiring mind. How is it that the bees do not mix up pollens hopelessly as they pass from flower to flower? If a humble-bee dusts the pistil of a red-clover with the pollen of an aconite, the flower will not be "much forrarder." The answer is threefold. Some insects are specialists they know their flowers "like good botanists," and they keep to them consistently. But, secondly, even when the insect is not a specialist it tends on a given journey or forenoon to keep to one kind of flower. What Aristole observed, the bees do not fly at random from one kind of blossom to another, has been amply confirmed. The mouth parts are suited for particular kinds of flowers; thus the hive-bee's tongue is not long enough to reach the nectar of the ordinary corolla of the red clover which is easily reached by the humble-bee.

News from Scouts.

Moreover, of a summer morning hive-bees pay considerable heed to the tidings brought in by the scouts, who inform them in some way or other which flowers are most profitable at the time. It must be remembered that true bees deal very intimately with the pollen-grains; they moisten them with their mouth and put cakes of them in a depression or basket on one of the joints of the hind-legs, and the next joint is enlarged into a hairy brush. The pollen that is of use to the next flower is the loose dust entangled on various appropriate parts of the bees body, appropriate in the sense that they knock against the stigma and deposit the grains there. Finally, it appears that foreign pollen dusted on to the stigma usually dies; only the proper kind of pollen sends out a pollen tube. Add these three points together—(1) the specialisms of insect visitors,

(2) their consistency on a given journey,

and (3) the specificity of the pollen, which only grows on its appropriate soil (the stigma of its kind), and you have the answer to the question: Why is there not a hopeless mixture of pollen.

How do the Insects "Know"?

But the next question is: How are insects guided to the profitable flowers, or how do they recognise them as the flowers they are out to visit on that journey? The answers given to this question have been so discrepant, some authorities laying emphasis on colour-sense, and others on the sense of smell, and others on memories which

associate certain shapes and textures with abundant nectar, and so on, that we are glad to avail ourselves of Professor Bouvier's recently published "Psychic Life of Insects" (Fisher Unwin, 1922), which takes a critical survey of the known facts.

Many observers have concluded that bees pay most frequent visits to flowers (or even baited paper) with gaudy colours; but there has rarely been any firm discrimination between colour as such and the brilliance of the reflecting surface. What counts for most is conspicuousness against the green background, and bees are in some measure colour blind! Uncovered flowers attract more visitors than the same flowers next door but shaded by leaves; highly coloured flowers with slight odour, like dahlias, attract more visitors than there fragrant unconspicuous neighbours, such as mignonette; conspicuous flowers get far more visitors than honey in a beaker next door.

The conspicuousness may depend on form and size as well as colour, as is shown by the attentions some butterflies pay to the big white flowers of the field convolvulus. The visits cease when the corolla is removed, though the nectaries remain intact. Yet after some time various kinds of insect visitors undoubtedly learn to come to honey-flowers whose petals have been cut off. This is a very suggestive fact.

"Never Trust to Colour."

Then there is fragrance, which certainly counts for much among hive-bees, for they are very richly endowed with smelling hairs. Darwin said that "bumble-bees and honey-bees are good botanists" because they recognise the same kind of flower though the colour is different. They obey the advice of the father of botany: "Never trust to colour." It is probably the flower's characteristic perfume, mainly due to essential oils, that enables the bees to become "good botanists." Kerner saw a convolvulus hawkmoth fly straight to the invisible flowers of a honeysuckle over a hundred yards away. For a long range, then, where colour, brilliant surface, and shape cannot count as guides, certain insects, like bees and moths, may be attracted by odours diffusing through the air. When they come near, the other influences may tell. On the other hand, a bee attracted to a flower by its conspicuousness may turn away when it detects the perfume.

The Role of Learning.

The question of the guidance of insect visitors to useful flowers has got into some confusion because different insects are differently attracted, and different flowers have different advertisements. Each case must be studied by itself. But there is more than that. Too little attention has been given to the capacity insects have of profiting by individual experience. They are not altogether instinctive automata; they are intelligent learners. They can attend and they can remember. They can build up associations between certain advertisements (colour, shape, fragrance) and good meals. Forel showed that bees learn to force their way into flowers covered up by leaves; Perez showed that

bees learn to visit the scarlet pelargonium, which they dislike, provided a little honey is introduced for a while into the corollas; Bouvier and others have shown that hive-bees learn to profit by slits and holes which other bees have made as short cuts to the nectaries; and many observers have noticed that bees learn to give up visiting flowers which promise well but are in reality disappointing. No doubt bees are dominated by their hereditary inborn instincts, but we fail to make sense of their behaviour unless we also give them credit for an intelligent criticism of advertisements.

DEPARTMENTAL NOTES.

Mr. A. G. G. Ellis, Inspector of Agriculture, Johore, proceeded to Europe on vacation leave on August 5th, 1922, and resigned the service on November 21st, 1922, for family reasons.

Mr. Ellis joined the department on May 3rd, 1913 as an Assistant Agricultural Inspector and was placed in charge of Perak North. His headquarters were at first in Kuala Kangsar, but after a few months were moved to Taiping. Mr. Ellis remained in Perak until January 27th, 1919, when he was appointed to act as Chief Agricultural Inspector during the absence on leave of Mr. F. W. South. While in Perak Mr. Ellis did valuable work in organising the then newly established inspection division there and in carrying on the work on sound lines. On at least two occasions he was for a period in charge of this work in the whole State.

Mr. Ellis proceeded on leave to Europe on November 23rd, 1919 and returned on April 22nd, 1921. He was seconded for service as Inspector of Agriculture, Johore on May 19th, 1921, and proceeded to reorganise and develop the local department in that State.

Mr. Ellis was an energetic and capable officer who had done much useful work. It is unfortunate that he has had to resign a promising career after nine years service. The departure of so experienced an officer is a serious loss to the department.

Mr. A. E. C. Doscas, Assistant Agricultural Inspector, Negri Sembilan, was seconded to act as Inspector of Agriculture, Johore, in place of Mr. Ellis on August 3rd, 1922 (*Vide* Notification No. 5337 in the Federated Malay States Government Gazette of September 8th, 1922).

Mr. W. H. Barnes, Special Field Officer, Kuala Pilah was appointed to act as Assistant Agricultural Inspector, Negri Sembilan, in place of Mr. Doscas (*Vide*-Notification No. 5336 in the Federated Malay States Government Gazette of September 8th, 1922).

April 30th 1923.